Technical Training on BAT/BEP Application in Metal Scrap Smelting Industry

BAT/BEP Application

in Metal Scrap Smelting Industry

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POPs: some fundamental question

- What are Persistent Organic Pollutants?
- Why should we worry about?
- Where they may be produced?
- How much?
- What has been done?
- What can we do?

Persistent Organic Pollutants

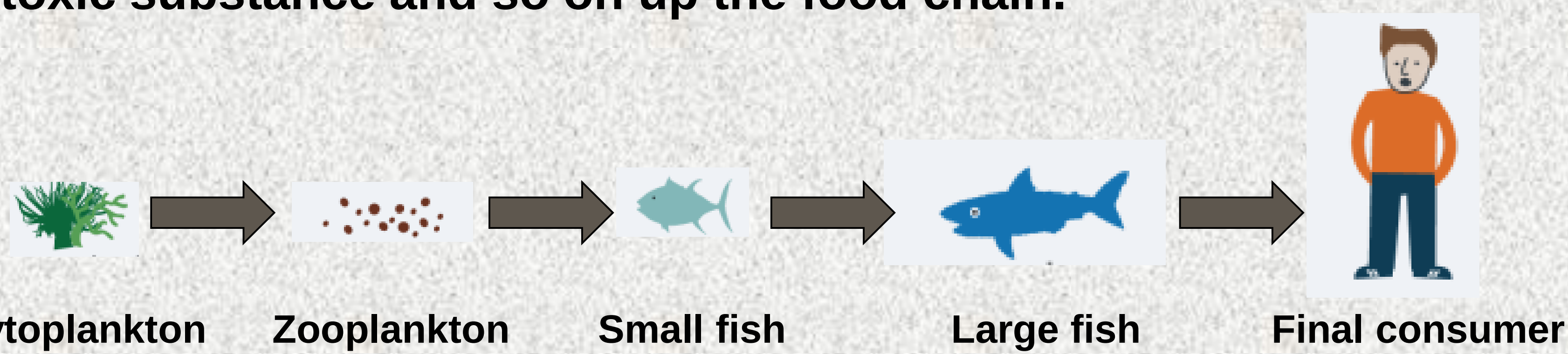
Persistent Organic Pollutants (POPs) are chemical substances of global concern that possess a particular combination of physical and chemical properties:

- ✓ **remain intact for exceptionally long periods of time (many years);**
- ✓ **due to their potential for long-range transport become widely distributed throughout the environment;**
- ✓ **accumulate in the fatty tissue of living organisms including humans;**
- ✓ **are toxic to both humans and wildlife.**

Persistent Organic Pollutants: bioaccumulation and biomagnification

POPs concentrate in living organisms through a process called bioaccumulation: continued exposure to small amounts leads to an accumulation in the body's tissues up to dangerous levels.

Biomagnification operate across a complex chain of events. Small microorganisms can begin the process of accumulation. These are eaten by larger organisms who continue to process of concentrating the toxic substance and so on up the food chain.



Persistent Organic Pollutants: toxicity

Specific effects of POPs can include:

- ✓ **damage to the central and peripheral nervous systems;**
- ✓ **damage to the reproductive system;**
- ✓ **damage to the immune system;**
- ✓ **damage to the endocrine system (altering the hormonal system);**
- ✓ **developmental and carcinogenic effects.**

POPs can be transferred through the placenta and breast milk, so these chemicals can affect exposed individuals as well as their offspring.

Why should we worry about ?

- Toxicity
- Persistence
- Long-range transport
- Bio-magnification

→ ***No tolerance***

A global issue → a global response

In 2004, the Stockholm Convention on Persistent Organic Pollutants was ratified by governments to decrease environmental and human exposure to these substances.

POPs listed in the Stockholm Convention (pesticides and industrial chemicals)

Intentionally produced chemicals:

- *Aldrin*
- *Chlordane*
- *DDT*
- *Dieldrin*
- *Endrin*
- *Heptachlor*
- *Mirex*
- *Toxaphene*
- *Chlordecone*
- *Decabromodiphenyl ether (commercial mixture, c-decaBDE)*
- *Tetrabromodiphenyl ether and pentabromodiphenyl ether*
- *Hexachlorobenzene*
- *Hexabromobiphenyl*
- *Hexabromocyclododecane*
- *Hexabromodiphenyl ether and heptabromodiphenyl ether*
- *Hexachlorobutadiene*
- *Alpha hexachlorocyclohexane*
- *Beta hexachlorocyclohexane*
- *Lindane*
- *Pentachlorobenzene*
- *Pentachlorophenol and its salts and esters*
- *Polychlorinated biphenyls (PCB)*
- *Polychlorinated naphthalenes*
- *Short-chain chlorinated paraffins (SCCPs)*
- *Technical endosulfan and its related isomers*
- *Perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride*

POPs listed in the Stockholm Convention (unintentional production – Annex C)

Unintentionally produced chemicals:

- ⇒ ***Hexachlorobenzene (HCB)***
- ⇒ ***Hexachlorobutadiene (HCBD)***
- ⇒ ***Pentachlorobenzene (PeCB)***
- ⇒ ***Polychlorinated biphenyls (PCB)***
- ⇒ ***Polychlorinated dibenzo-p-dioxins (PCDD)***
- ⇒ ***Polychlorinated dibenzofurans (PCDF)***
- ⇒ ***Polychlorinated naphthalenes (PCN)***

Unintentional Persistent Organic Pollutants (U-POPs)

Unintentionally produced chemicals, such as dioxins, are by-products resulting from some industrial processes and from combustion (for example, municipal and medical waste incineration and backyard burning of trash).

The Stockholm Convention's goal for unintentionally produced POPs is their continuing minimization and, where feasible, ultimate elimination.

Formation of U-POPs

There are three main mechanisms that generate and release U-POPs:

- **Releases of POPs present in the material being burned/processed that are not destroyed by the process;**
- **Formation from precursors that generate POPs during combustion;**
- ***De novo* synthesis from carbon, hydrogen, oxygen, and chlorine, in the presence of certain metals acting as catalysts (e.g. Cu, Fe).**

Formation of U-POPs

There are three main mechanisms that generate and release U-POPs:

- Releases of POPs present in the material being burned/processed that are not destroyed by the process;
- Formation from precursors (such as chlorobenzenes and chlorophenols) that generate POPs during combustion;
- *De novo* synthesis from carbon, hydrogen, oxygen, and chlorine, in the presence of certain metals acting as catalysts (e.g. Cu, Fe).

De novo synthesis of PCDD/F

The de novo synthesis theory is considered the major mechanism by which PCDD/F are formed in thermal industrial processes.

The basic set of conditions required for de novo synthesis of PCDD/F are a solid matrix containing carbon structures (fly ash), organic or inorganic chlorine, copper or iron ions, an oxidizing atmosphere, and an optimal temperature range of 250 to 450°C with a peak around 325°C.

De novo synthesis of PCDD/F

Certain operating conditions increase the potential for PCDD/F formation including:

1. **incomplete combustion of a fuel**
2. **an oxidizing atmosphere**
3. **presence of a chlorine source**
4. **fly ash surfaces with degenerated graphitic structures (carbon source)**
5. **presence of catalytic metals (especially copper, but also iron, manganese and zinc)**
6. **temperature/time history (optimal temperature range lies between 250 and 450°C)**

Major factors influencing dioxin formation

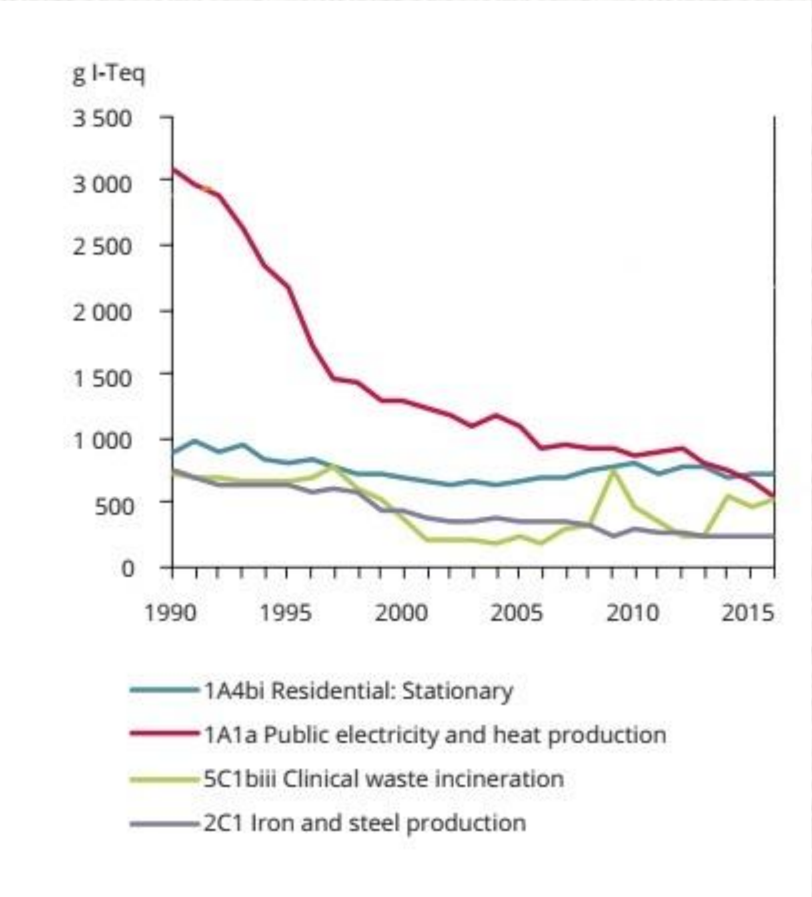
- **The process feed (raw materials);**
- **The process operating conditions (combustion quality);**
- **The off-gas cooling conditions (residence time, critical temperature for *de novo* synthesis);**
- **Memory effects (i.e. dust cumulated inside the ducts).**

Main sources of PCDD/F emissions to air

PCDD/PCDF emissions per sector, reference year: 1995 (UNEP, 1999).

Sector	Global Flux g I-TEQ/year	Global Flux %
Waste incineration	7,241	69
Iron and steel industry	1,083	10
Non-ferrous metals	804	8
Small combustion units	354	3
Mineral production	234	2
Industrial combustion plants	204	2
Road transport	67	1
Power plants	57	1
Others	470	4
Total	10,514	100

PCDD/F emissions in the EU: trend from the four most important key categories, 1990-2016



Stockholm Convention on Persistent Organic Pollutants

Article 5

- Take measures to reduce the total releases derived from anthropogenic sources of each of the chemicals listed in Part I of Annex C…
- Parties shall promote in some cases and require in others the use of Best Available Techniques (BAT), and promote the application of Best Environmental Practices (BEP) for source categories listed in Parts II and III of Annex C.

Best Available Techniques

"Best" means the most effective and advanced stage in the development of activities and their methods of operation ... to prevent and … generally to reduce releases of chemicals listed in Part I of Annex C.

“Available” means those techniques that are accessible to the operator and that are developed on a scale that allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages;

“Techniques” includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned;

Best Environmental Practices (BEP)

Definition under the Stockholm Convention:

"BEP means the application of the most appropriate combination of environmental control measures and strategies".

A more detailed description of BEP could not be reached during the negotiation of the Convention.

We can think BEP as the infrastructural measures, which in part extend beyond the level of individual installations and which, in combination with BAT, take them towards a reduction strategy which must be implemented comprehensively.

Stockholm Convention on Persistent Organic Pollutants

Annex C, Part II

(a) Waste incinerators, including co-incinerators of municipal, hazardous or medical waste or of sewage sludge;

(b) Cement kilns firing hazardous waste;

(c) Production of pulp using elemental chlorine or chemicals generating elemental chlorine for bleaching;

(d) The following thermal processes in the metallurgical industry:

- (i) Secondary copper production;
- (ii) Sinter plants in the iron and steel industry;
- (iii) Secondary aluminum production;
- (iv) Secondary zinc production.

Stockholm Convention on Persistent Organic Pollutants

Annex C, Part III

(a) Open burning of waste, including burning of landfill sites;

(b) Thermal processes in the metallurgical industry not mentioned in Part II;

(c) Residential combustion sources;

(d) Fossil fuel-fired utility and industrial boilers;

(e) Firing installations for wood and other biomass fuels;

(f) Specific chemical production processes releasing unintentionally formed persistent organic pollutants, especially production of chlorophenols and chloranil;

(g) Crematoria;

(h) Motor vehicles, particularly those burning leaded gasoline;

(i) Destruction of animal carcasses;

(j) Textile and leather dyeing (with chloranil) and finishing (with alkaline extraction);

(k) Shredder plants for the treatment of end of life vehicles;

(l) Smouldering of copper cables;

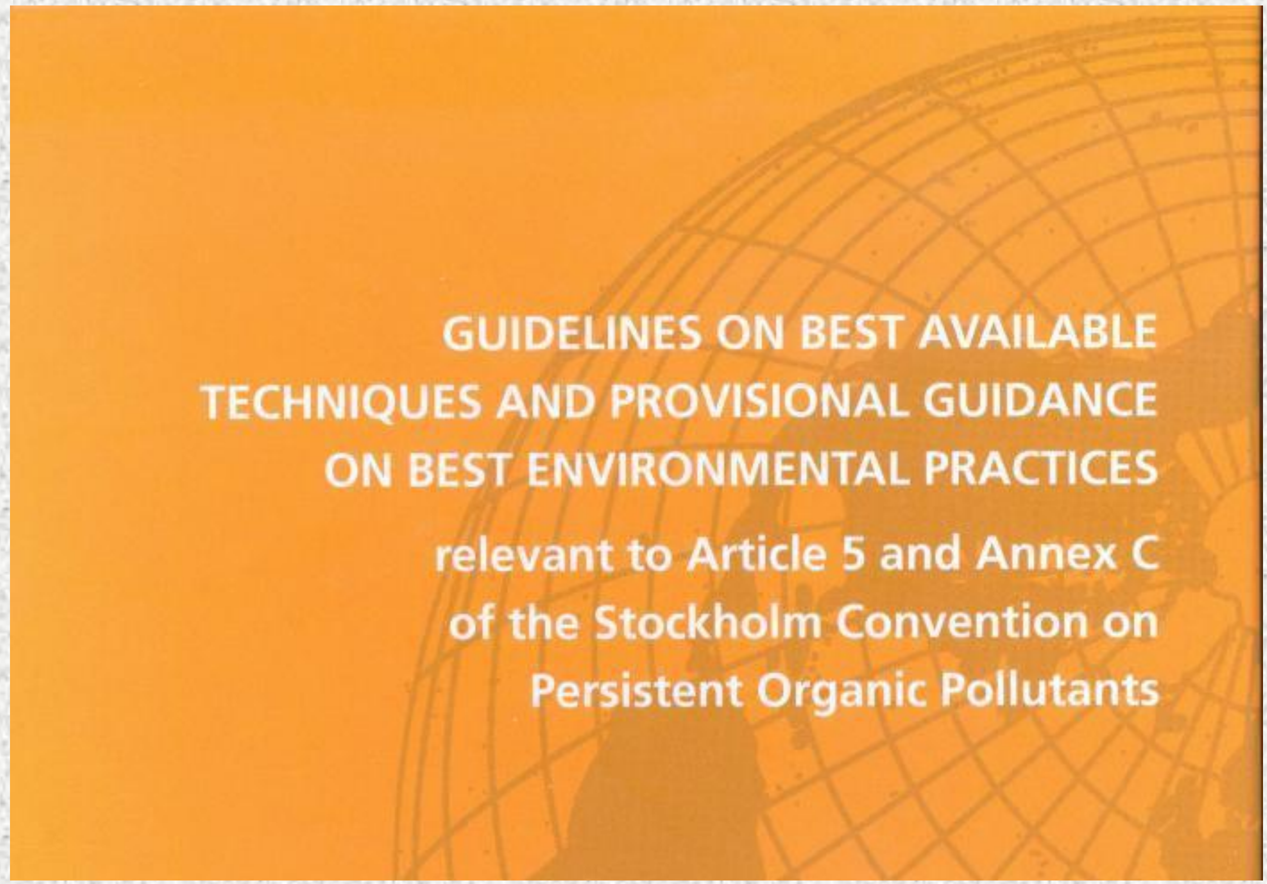
(m) Waste oil refineries.

Annex C, Part III

Thermal processes in the metallurgical industry not mentioned in Part II:

- (a) Secondary lead production;
- (b) Primary aluminum production;
- (c) Magnesium production;
- (d) Secondary steel production;
- (e) Primary base metals smelting.

Guidelines/Guidance on best available techniques and best environmental practices



http://chm.pops.int/Implementation/BATandBEP/BATBEPGuidelinesArticle5/tabid/187/Default.aspx

Guidelines/Guidance on best available techniques and best environmental practices

Section V: Guidance/guidelines by source categories: Source categories in Part II of Annex C

V.A Waste incinerators
- (i) Municipal solid waste, hazardous waste and sewage sludge
- (ii) Medical waste

V.B Cement kilns firing hazardous waste

V.C Production of pulp using elemental chlorine or chemicals generating elemental chlorine

V.D Thermal processes in the metallurgical industry
- (i) Secondary copper production
- (ii) Sinter plants in the iron and steel industry
- (iii) Secondary aluminium production
- (iv) Secondary zinc production

Guidelines/Guidance on best available techniques and best environmental practices

Section VI: Guidance/guidelines by source categories: Source categories in Part III of Annex C

VI.A Open burning of waste, including burning of landfill sites

VI.B Thermal processes in the metallurgical industry not mentioned in Annex C Part II

- (i) Secondary lead production
- (ii) Primary aluminium production
- (iii) Magnesium production
- (iv) Secondary steel production
- (v) Primary base metals smelting

Guidelines/Guidance on best available techniques and best environmental practices

Tool for estimating emission inventories of PCDDs/PCDFs and other U-POPs

Toolkit

for Identification and Quantification of Releases of Dioxins, Furans and Other Unintentional POPs

under Article 5 of the Stockholm Convention

Primary and Secondary Metal Production

Primary metal production refers to the processing of ores to obtain metals. These processes vary, but usually involve chemical reduction (by high temperatures and addition of substances such as carbon) and purification processes.

Secondary metal production refers to the recovery of metals from secondary sources such as scrap. Metal recycling has the potential for higher levels of dioxin formation because the scrap metal usually contains paints, oils, coatings, plastics, and other impurities that may provide both chlorine and carbon.

Secondary Metal Production

Secondary metals can be recovered from scrap metals or from metal-bearing ash, residues, slag, slugs, dross, skimming, scaling, dust, powder, sludge, cake and catalysts. Scrap metals arise from predominantly three sources:

- ✓ **home, plant or "runaround" scraps are arising from metals production;**
- ✓ **prompt or manufacturing scrap arises from the production of intermediate products or from the machining or forming of final products. The scrap has the form of turnings, borings, clips, punch, trim or rejected (off-specification) parts. This scrap is clean and of known composition;**
- ✓ **post-consumer scrap is what gets the attention of waste managers. It arises from obsolete items, such as demolished buildings, end-of-life automobiles, appliances or electronic devices.**

Primary and secondary measures

Measures to control and abate emissions to the environment generally fall into two categories:

- **primary or process-integrated measures that attempt to prevent or minimize the pollutant being formed and emitted from the main process;**

- **secondary or end-of pipe measures that attempt to destroy or recapture emissions after they have been formed and emitted from the main process.**

From a general point of view, it is better to avoid PCDD/Fs formation rather than abate them after their formation.

Generic primary measures

Primary measures identified to prevent or minimize the formation of PCDDs/Fs:

- **feed material selection;**
- **feed material preparation (i.e. de-coating and de-oiling processes, stripping cable insulation);**
- **effective process control to establish and maintain optimum operating conditions that minimize PCDD/Fs generation;**
- **continuous parameter monitoring.**

BAT for scrap metal handling

- Apply roads with hard surfaces;
- Clean roads with hard surfaces with sweeper and moisten roads with non-hard surfaces with fixed or mobile sprinkler system;
- avoid emission of dust from traffic;
- store the scrap according to different criteria (e.g. size, alloys, degree of cleanliness);
- provide scrap storage under cover and/or on impermeable surfaces (i.e. concrete floors) with a drainage and collection system;
- avoid emission of dust when storing metal scrap outside (e.g. install wind reduction screens) and when transporting, loading and unloading materials.

Sorting of scrap

The sorting of scrap implies the selection of separate fractions in quality or grade. Separation methods can include:

- **Hand sorting;**
- **Drum magnet;**
- **Media separation;**
- **Eddy current separator;**
- **Color sensor.**

Sorting of feed material should be conducted prior to smelting. The selection of the scrap is effective to reduce the entry of contaminants in the melting furnace, including contaminants that can lead to the formation of dioxins.

Scrap pre-cleaning

Scrap pre-cleaning (de-coating, de-laquering) is a key determinant in secondary aluminum production.

Part of the aluminum scrap is often wet, oily, chemically surface treated, coated, plastic laminated or adhesively bonded.

Dedicated cleaning is favorable as contaminants may cause oxidation on melting, produce dross, contaminate the melt and decreases metal recoveries. De-coating also improves safety, has lower emissions and improves energy efficiency.

Most common technology is thermal de-coating of scrap in a rotary kiln at a temperature of approx. 500°C. The kiln must be equipped with a post-combustion chamber and activated carbon injection for an effective dioxin control.

BAT for improving the use of scrap

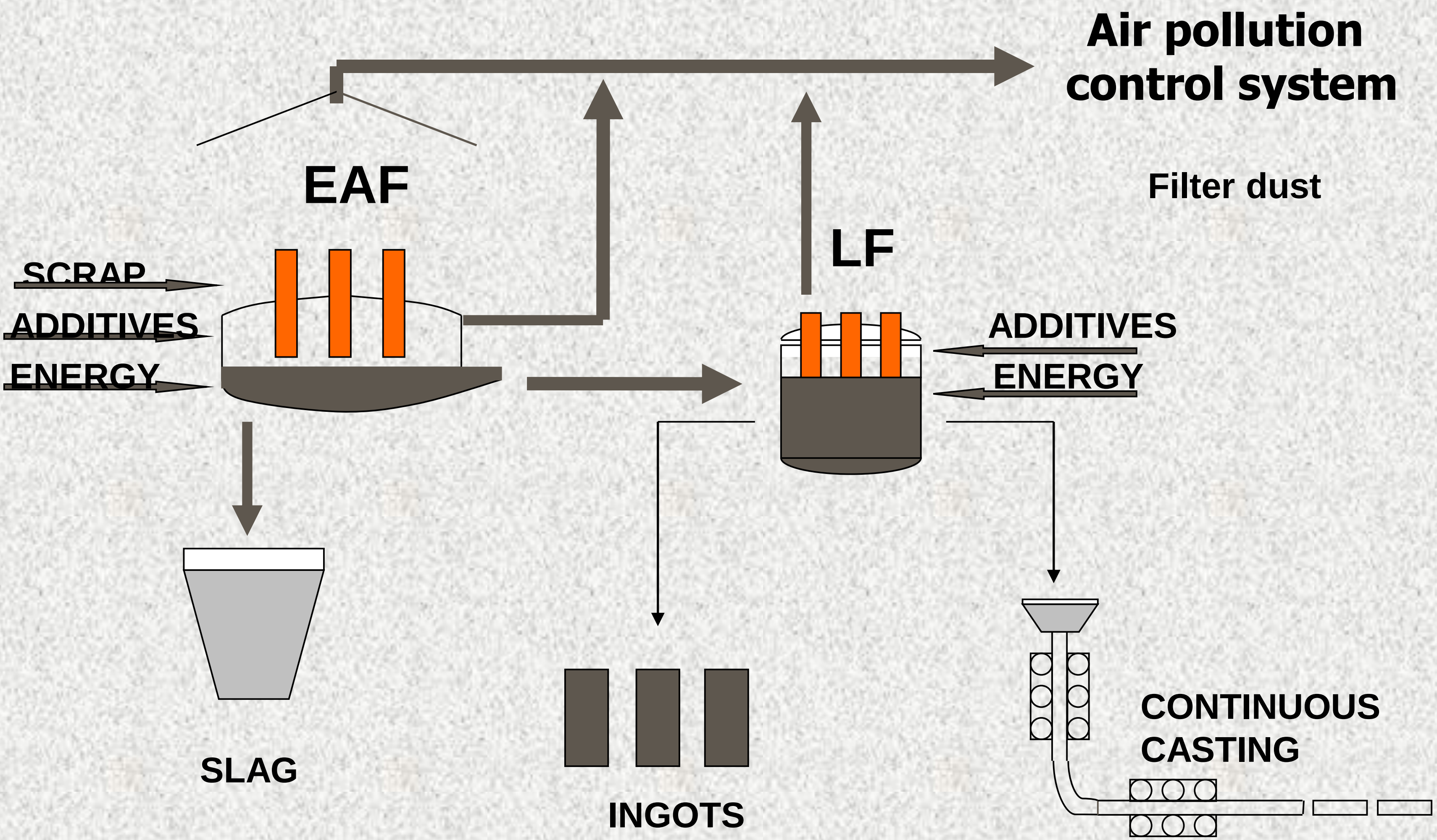
- **specification of acceptance criteria suited to the production profile in purchase orders of scrap;**
- **having procedures to exclude scrap that is not suitable for use in the installation;**
- **having a good knowledge of scrap composition by closely monitoring the origin of the scrap;**
- **check, as far as practicable, for contaminants and evaluate small quantities of plastic (e.g. as plastic coated components);**
- **scrap sorting to minimize the risk of including contaminants, particularly PCBs and oil or grease;**
- **fixing the absence of mercury in scrap purchase contracts;**
- **refusal of scrap which contains visible electronic components and assemblies;**
- **adequate reception facilities and check deliveries.**

Generic secondary measures

Secondary measures capable to reduce PCDD/PCDF releases into the environment from metallurgical plants:

- **efficient fume and gas collection;**
- **high efficiency dust removal equipment;**
- **continuous monitoring of APCS;**
- **Post-combustion of the waste gas at a temperature above 850°C followed by a rapid quenching of the hot gases to temperatures below 250°C to avoid de novo synthesis;**
- **Adsorption/absorption onto materials such as activated carbon in a fixed bed or moving bed reactor or by injection into the gas stream, and subsequent removal as filter dust.**

Electric arc furnace steel-making process



Electric arc furnace steel-making process

Scrap processed in secondary steel facilities comes mainly from construction and demolition, automobiles, other vehicles, machinery and appliances. The process combusts impurities in scrap and can results in dioxin emission, especially when scrap is contaminated with paints, plastics, lubricants, and other organics including phenols, chlorinated plastics such as PVC and PCBs (e.g. from small capacitors in old appliances).

Dioxin Toolkit
Emission factors for EAF steel-making

µg TEQ/t of liquid steel

Classification	Air	Water	Land	Product	Residue
Dirty scrap (cutting oils, general contamination), scrap preheating, limited controls	10	ND	NA	NA	15
Clean scrap/virgin iron, afterburner and fabric filter	3	ND	NA	NA	15
Clean scrap/virgin iron, EAF designed for low PCDD/PCDF emission	0.1	ND	NA	NA	0.1

Primary measures in the electric arc furnace steel-making process

Pollution prevention practices to prevent the entry of contaminants into EAFs include changes in material specifications and types of raw materials accepted (such as avoidance of oily scrap).

It could be required that metal shredders remove any small capacitors (that may contain PCBs) from electrical and electronic equipment prior to shredding, thereby preventing PCB releases as well as reducing dioxin emissions.

Primary measures in the electric arc furnace steel-making process

Certain measures that improve operational and energy efficiency appear also to reduce dioxin emissions, such as minimizing the time the roof is open to receive the metal charge, reducing air infiltration into the furnace, avoiding operational delays, monitoring off-gas entry temperature at the bag-house, preventive maintenance and improving fabric filter design and material, as well as bag-house operation.

Primary measures in the electric arc furnace steel-making process

A specific primary measures identified to prevent or minimise the formation of PCDDs/PCDFs from the electric arc furnace steel-making process:

- **avoid scrap pre-heating if post-combustion is not performed.**

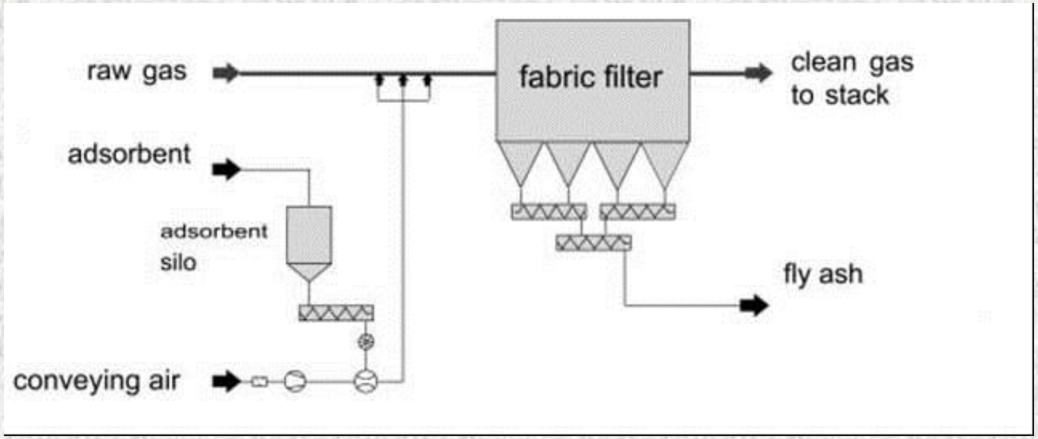
Control of PCDD/F emissions through activated carbon injection in combination with fabric filters

Effect of carbon injection on PCDD/F concentrations in the waste gas of a sinter plant in Germany

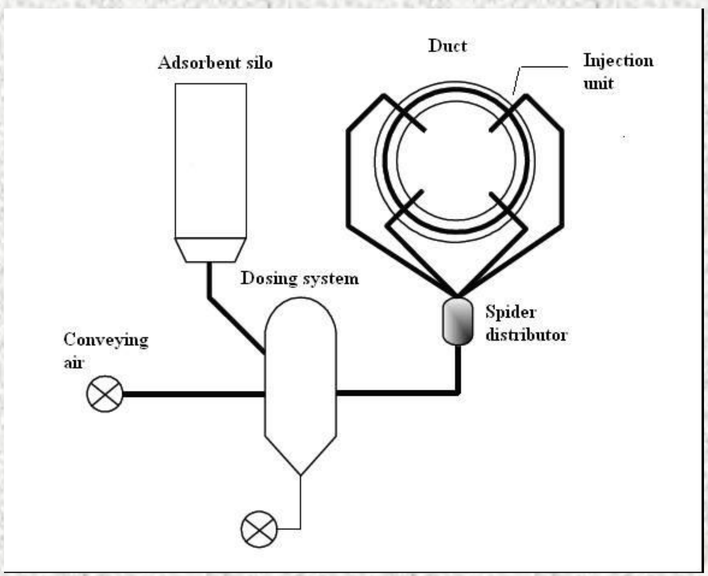
Adsorbent mg/m³	Concentration ng TEQ/m³	Emission Factor μg TEQ/t sinter
0	9.83	26.6
50	1.86	3.78
75	0.94	1.99
100	0.09	0.19
145	0.02	0.045

Sized lignite coke injection technology is largely used in a number of European EAF steel-making plants to supplement the fabric filter technology. Reported emission tests indicate that this technique achieves PCDD/PCDF emission concentrations of less than 0.1 ng TEQ/Nm³ consistently.

Control of PCDD/F emissions through activated carbon injection in combination with fabric filters



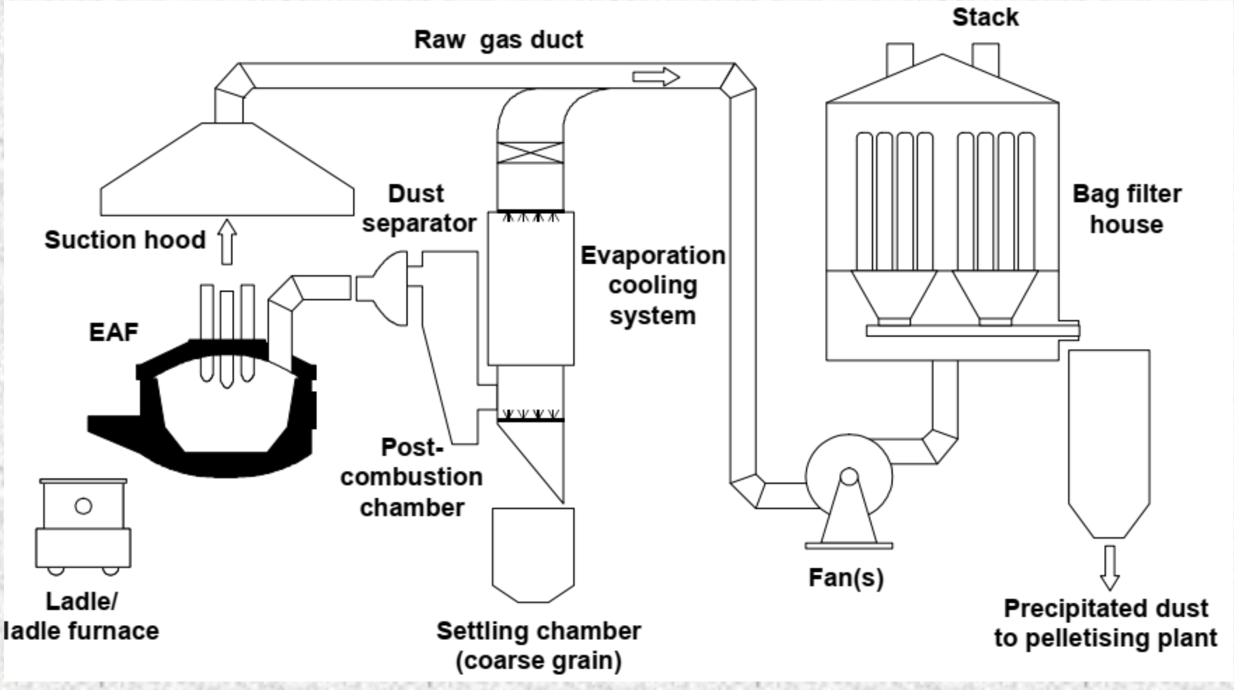
Schematic of an air pollution control system based on fabric filter with activated carbon injection



Schematic of an adsorbent injection system

Reduction of PCDD/F by means of post-combustion and quenching

Post-combustion in a combustion chamber reduces the emission of compounds such as PCDD/F. To prevent the de novo synthesis of PCDD/F, it is essential to have a rapid cooling (quenching) of the fumes as soon as possible after post-combustion to a temperature of below 250 °C.



Badische Stahlwerke (BSW) in Germany

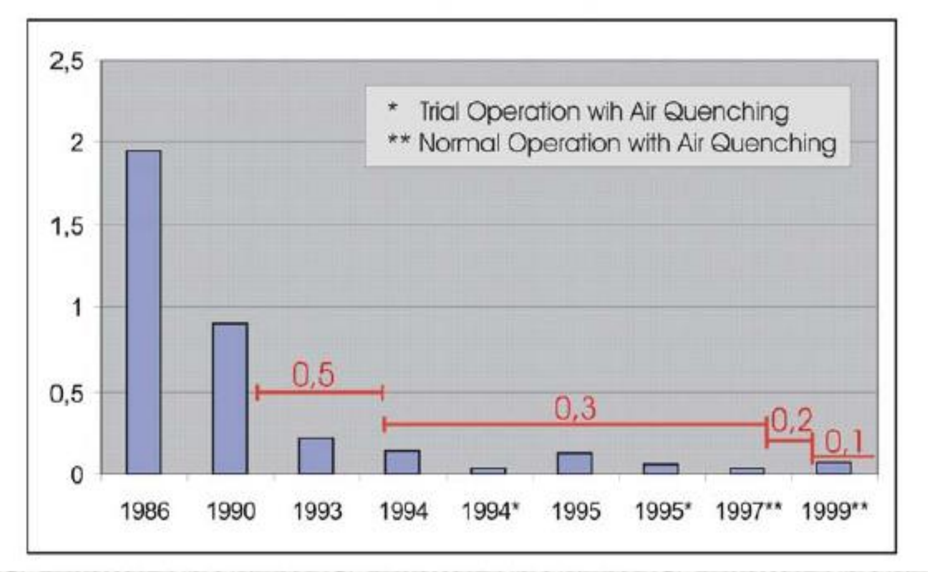
Two electric arc furnaces, 1.8 million tons of steel per year

Limiting values for permits

1991: 0.5 ng TEQ/Nm³
1994: 0.3 ng TEQ/Nm³
1998: 0.2 ng TEQ/Nm³
1999: 0.1 ng TEQ/Nm³

Yearly average emission concentrations

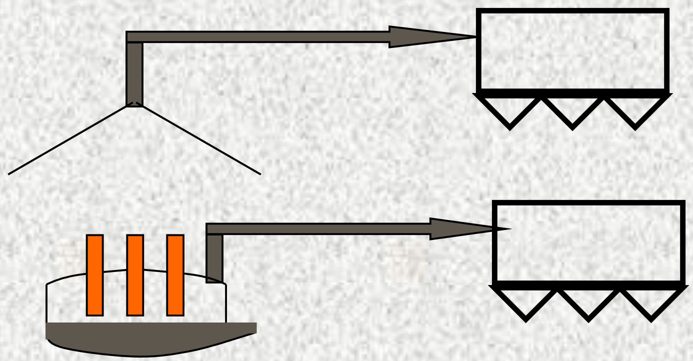
1986 ~ 2 ng TEQ/Nm³
1999 < 0.1 ng TEQ/Nm³



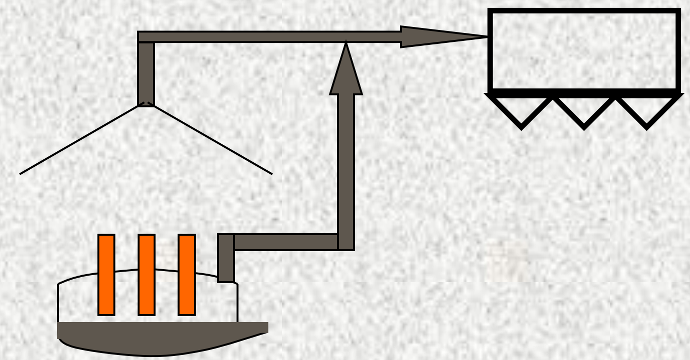
These performance were obtained with:

- **stopping scrap preheating;**
- **doing extensive development works on de-dusting system (succeeding to comply with a value of 1 mg/Nm³ at 1.8 million Nm³/h);**
- **installing a quenching system**

Change from an independent to a joined ducting and cleaning system



Independent system



Joined system

According to Japanese data, emission concentrations in four different plants decreased from an average of 3.93 ng I-TEQ/Nm^3 to an average of 0.79 ng I-TEQ/Nm^3, with an 80 % emission reduction.

Two examples of application of BAT/BEP in the electric arc furnace steel-making process

A) By improving and optimizing post-combustion and quenching and by injecting activated carbon in the flue gases of an EAF in Italy, PCDD/F emissions decreased from 1.7 ng I-TEQ/Nm^3 to < 0.1 ng I-TEQ/Nm^3.

B) Improvement of scrap quality in an EAF in China led to a reduction of PCDD/PCDF concentrations in the flue gases emitted into the atmosphere and in filter dust .

	Emission rate (g TEQ/a)		
	Air	Filter dust	Total
Baseline scenario	0.33	5.06	5.39
Modified scenario	0.19	2.86	3.05

Secondary Aluminum Production

Secondary aluminum plants recover aluminum from scrap such as used beverage cans, foundry returns, other aluminum scrap, and dross.

Unintentionally produced POPs are released from pre-processing operations (such as scrap drying/de-coating/de-lacquering) and furnace operations (i.e., melting, holding, refining, fluxing, or alloying).

Dioxin Toolkit.
Emission factors for secondary aluminum production

µg TEQ/t of aluminum

Classification	Air	Water	Land	Product	Residue
Minimal treatment of inputs and simple dust removal	100	ND	NA	NA	200
Scrap pre-treatment, good controls, fabric filters with lime injection	3.5	ND	NA	NA	400
Optimized for PCDD/PCDF control- afterburners, lime injection, fabric filters and active carbon	0.5	ND	NA	NA	100
Shavings/turning drying (simple plants)	5.0	NA	NA	NA	NA
Thermal de-oiling of turnings, rotary furnaces, afterburners, and fabric filters	0.3	NA	NA	NA	NA

Scrap Dryers/De-lacquering kilns/De-coating kilns

- **Remove coatings and other contaminants that may be present in scrap prior to melting (e.g., oil, grease, lubricants, lacquers, rubber, and plastic laminates);**
- **In general, the scrap is combusted in furnaces before being smelted;**
- **Emissions: inorganics including particulate metals and organics including dioxins and furans;**
- **Without corresponding exhaust gas cleaning, pre-treatment simply leads to a shift of the emissions in the preceding process steps.**

Primary measures in secondary aluminum production

Specific primary measures identified to prevent or minimize the formation of PCDDs/Fs:

- **avoid hexachloroethane for demagging (removal of magnesium): hexachloroethane produces HCB.**

- **Use of argon or nitrogen bubbling as degassing agents (removal of hydrogen gas from the melt) instead that chlorine is capable to attain similar or even superior technical efficiency and performance.**

Secondary measures in secondary aluminum production

Activated carbon injection in a secondary aluminum plant.

Secondary copper production

A wide range of secondary raw materials are used (Cu content)

- **Mixed copper sludge (2-25 %)**
- **Computer scrap (15-20 %)**
- **Copper sludge (2-40 %)**
- **Copper-iron material (10-20 %)**
- **Brass dross, copper-containing ashes and slag (10-40 %)**
- **Shredded material (30-80 %)**
- **Copper-brass radiators (60-65 %)**
- **Mixed red brass scrap (70-85 %)**
- **Light copper scrap (88-92 %)**
- **Heavy copper scrap (90-98 %)**
- **Mixed copper scrap (90-95 %)**
- **Copper granules (90-98 %)**
- **Pure scrap (99 %)**

Dioxin Toolkit
Emission factors for secondary copper

µg TEQ/t of copper

Classification	Air	Water	Land	Product	Residue
Sec. Cu – Basic technology	800	0.5	NA	NA	630
Sec Cu – Well controlled	50	0.5	NA	NA	630
Sec. Cu – Optimized for PCDD/PCDF control	5.0	0.5	NA	NA	300

Shaft furnace for secondary copper production in Austria (1995-1998).

Flue gas flow: 27,000 m^3/h

Required emission limit: 0.4 ng I-TEQ/Nm^3

Changed conventional acrylic felts filter media used before with Gore-tex membrane filter bags.

The plant met the required emission limits without injecting activated carbon.

Secondary zinc production

The formation of dioxins in the combustion zone and in the cooling part of the off-gas treatment system may be possible in some processes particularly if plastic components are included in the secondary materials that are fed into a process.

Dioxins have also shown to be present in dusts from Waelz kilns treating EAF dust.

Dioxin Toolkit.
Emission factors for secondary zinc production

µg TEQ/t of zinc

Classification	Air	Water	Land	Product	Residue
Kilns with no APCS	1,000	ND	NA	NA	0.02
Hot briquetting/rotary furnaces, basic dust control, e.g. fabric filters, ESP	100	ND	NA	NA	1
Comprehensive pollution controls, e.g. fabric filters with active carbon/DeDiox technology	5	ND	NA	NA	1

B.U.S Metall GmbH and Zinkrecycling Freiberg GmbH Waelz kilns, Germany

	B.U.S. Metall (Acid)	Zinkrecycling (Basic)	B.U.S. Metall (Basic)
Raw gases (before adsorption stage, ng TEQ/Nm^3)	50-1000	1.5 - 2.1	8 - 23
Clean gas (ng TEQ/Nm^3)	1-25	0.01	0.01
Dust from sorption/ filter stage (ng TEQ/kg)	1000/140	0.9	38/0.5
Waelz oxide (ng TEQ/kg)	900-1620	60-500	10-30

Secondary lead production

Considerable quantities of lead are recovered from scrap, in particular vehicle batteries. PCDD/PCDF emissions may be linked to the use of PVC separators in vehicle batteries.

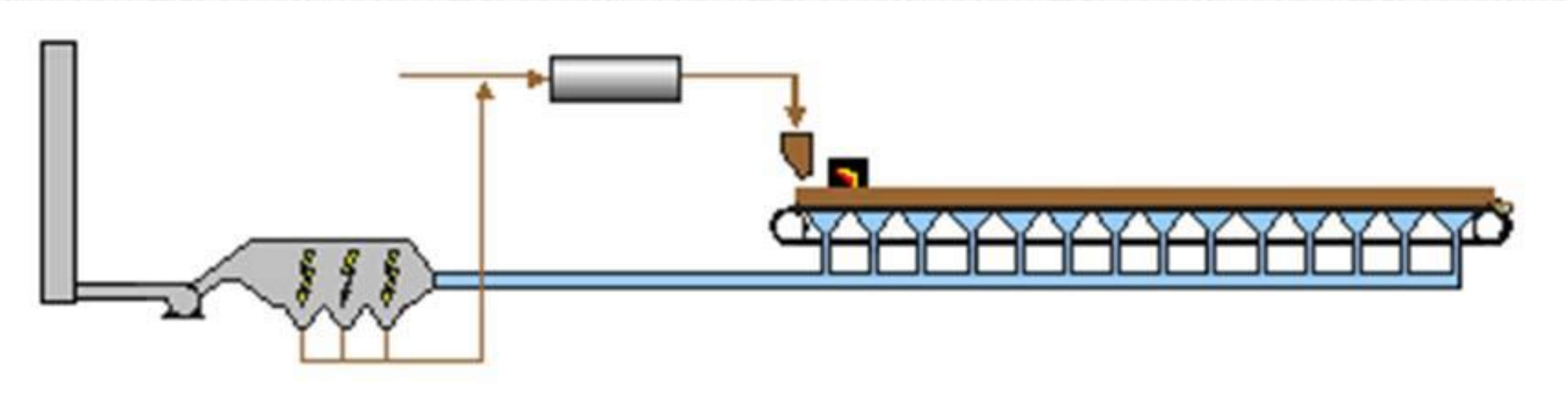
Replacing PVC separators with non-chlorinated materials could aid in the reduction of dioxin emissions from secondary lead production, given that PVC is one of the main sources of chlorine in scrap.

Dioxin Toolkit.
Emission factors for secondary lead production

µg TEQ/t of lead

Classification	Air	Water	Land	Product	Residue
Lead production from scrap containing PVC	80	ND	NA	NA	ND
Lead production from PVC/Cl2 free scrap, some APCS	8	ND	NA	NA	50
Lead production from PVC/Cl2 free scrap in highly efficient furnaces, with APC including scrubbers	0.05	NA	NA	NA	ND

Iron ore sintering



The sintering process is a pretreatment step in the production of iron whereby fine particles of iron ores and iron-bearing wastes (collected dusts, mill scale) are agglomerated by combustion. Sintering involves the heating of fine iron particles with flux and coke fines to produce a sinter with the size and strength characteristics necessary for feeding into the blast furnace.

Dioxin Toolkit
Emission factors for iron ore sinter plants

µg TEQ/t of Sinter Produced

Classification	Air	Water	Land	Product	Residue
High waste recycling including oil contaminated materials, no or limited air pollution control system	20	ND	ND	NA	0.003
Low waste use, well controlled plant	5	ND	ND	NA	1
High technology emission reduction	0.3	ND	ND	NA	2

Sidmar sinter plant, Belgium

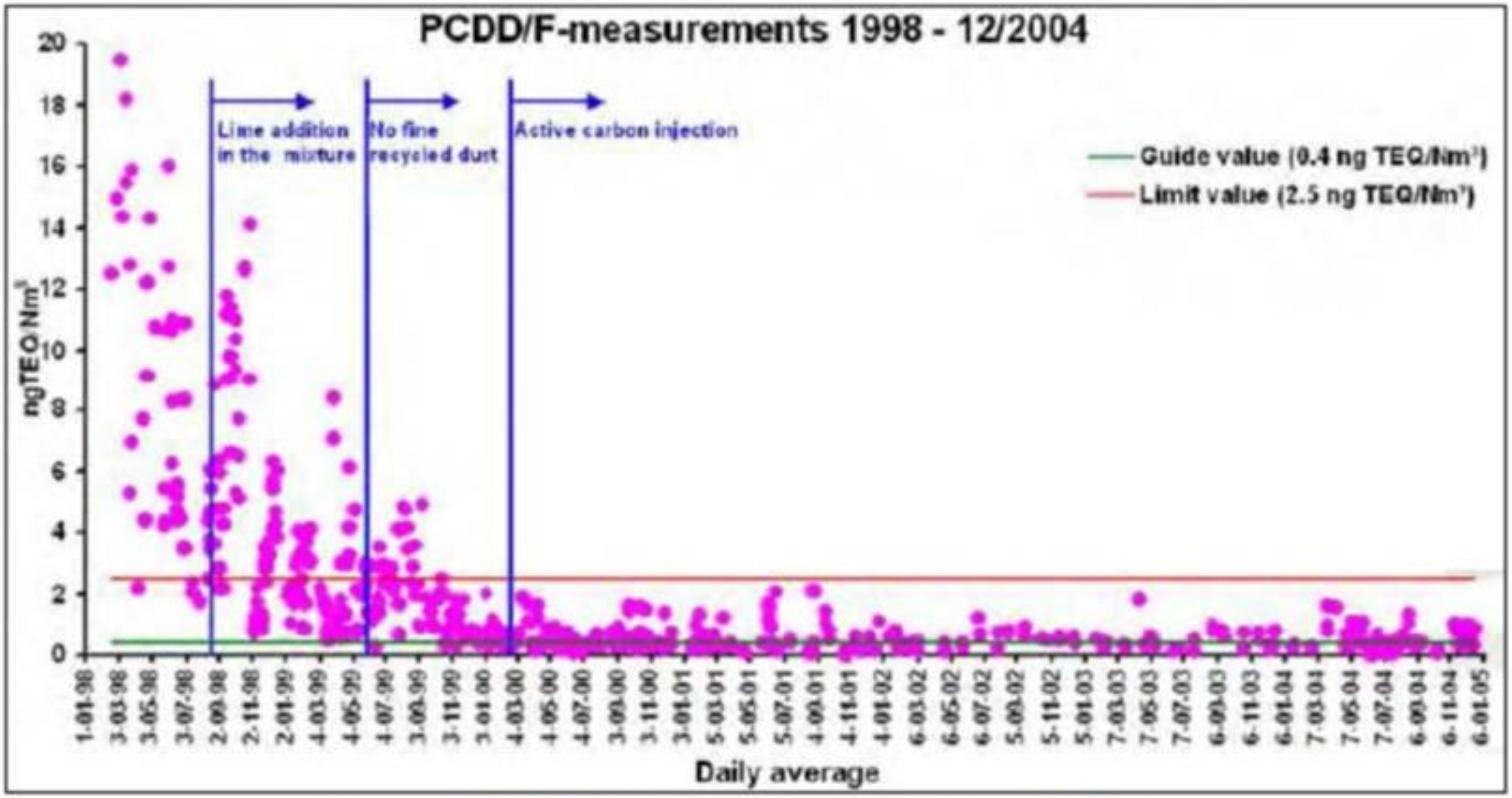
Implemented modifications:

- **chlorine input was reduced;**
- **oily mill scale was replaced;**
- **inhibitors were added;**
- **the process parameters were changed (the porosity of the sinter layer was increased);**
- **activated carbon was injected in the gas stream.**

Yearly average emission concentrations:

1998 = 7.7 ng TEQ/Nm^3
1999 = 2.0 ng TEQ/Nm^3
2000 = 0.58 ng TEQ/Nm^3
2002 = 0.48 ng TEQ/Nm^3

Sidmar sinter plant, Belgium



Emissioni di PCDD/F dell'impianto di Gent (Belgio)

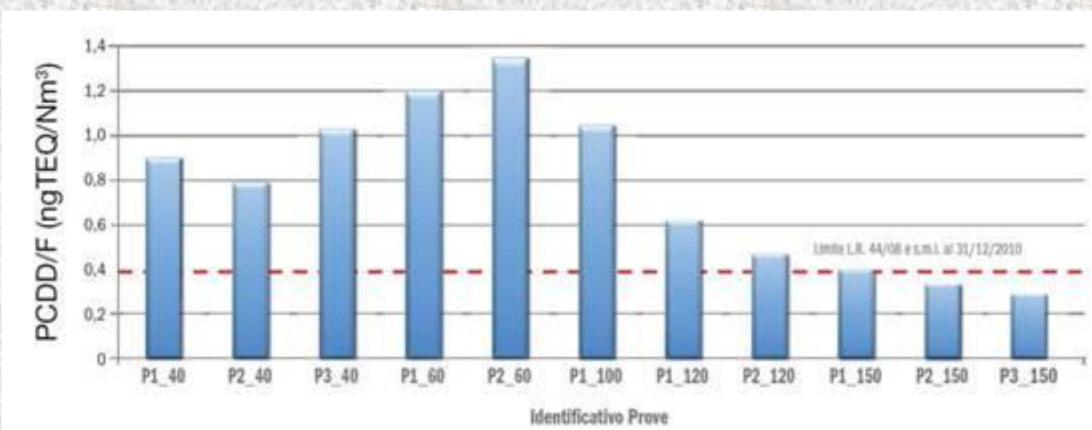
Ilva sinter plant, Italy

Yearly average emission concentrations:

1960 - 1999 = 600 – 900 g TEQ/year (estimated)
2007 - 2008 = 7 - 8 ng TEQ/Nm^3 (150 g TEQ/year)
2009 = 2.5 ng TEQ/Nm^3 (50 g TEQ/year)
2010 = 0.4 ng TEQ/Nm^3 (10 g TEQ/year)

Emission limit value: 0.4 ng TEQ/Nm^3 (1 January 2011)

Emission limit value: 0.1 ng TEQ/Nm^3 (from 2017)



Injection of activated carbon

Some concluding remarks

Recycling is important in a circular economy because it conserves valuable resources and prevents useful materials going to landfill sites as waste.

Because of the high value of metal scrap, there are also economic incentives that help to maintain high recycling levels.

A key aspect of environmental protection is to minimize releases of pollutants, including U-POPs. Process improvements can be identified and implemented with the goal of reducing emissions.

Technology (BAT/BEP) is crucial in determining and influencing the three sustainability pillars (economic, environmental and social), minimizing strong conflict between each dimension.

THANK YOU FOR YOUR ATTENTION

Any questions?